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FIELD-ASSISTED AND FLASH SINTERING OF NANOCRYSTALLINE YTTRIA: DENSIFICATION AND MICROSTRUCTURAL EVOLUTION

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Y_2O_3 ceramics have special chemical and physical properties such as high resistance to halogen-plasma corrosion and thermal stability. At the same time they are difficult to sinter. Conventional sintering requires very high temperatures typically >1400°C, and a vacuum or hydrogen atmosphere. We show that high-purity, undoped Y_2O_3 can be sintered nearly instantaneously to almost full density by flash-sintering, where densification occurs in a few seconds under a threshold condition of temperature and applied field [1]. The Y_2O_3 shows flash-sintering at the fields above 300 V/cm. For instance, full densification is achieved at 1133°C under a field of 500 V/cm. The flash event in Y_2O_3 is preceded by gradually accelerated field-assisted sintering (FAST). This hybrid behavior differs from earlier work on Y_2O_3-stabilized ZrO_2 where all shrinkage occurred in the flash mode. The microstructure of flash-sintered specimens indicated that densification was accompanied by rapid grain growth. The single-phase nature of flash-sintered Y_2O_3 was confirmed by high-resolution transmission electron microscopy (HRTEM). The non-linear rise in conductivity accompanying the flash led to Joule heating. It is postulated that densification and grain growth were enhanced by accelerated solid-state diffusion, resulting from both Joule heating and the generation of defects under the applied field.

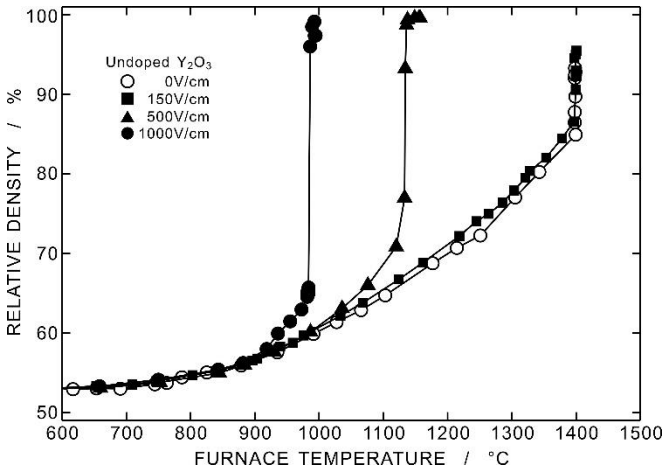

Figure 1 – Densification curves under different DC fields as a function of furnace temperature in undoped, high-purityY_2O_3. The data for conventional sintering are also shown as 0V/cm for comparison.

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